

# Digital Particle Image Velocimetry (DPIV) Used for Space-Time Correlations in Nozzle Flow



*Dual DPIV system setup in the Small Hot Jet Acoustic Rig facility. The light sheets from each of the DPIV systems are visible in this photograph.*

Long description of figure A man is shown seated at two computer monitors in front of a large experimental rig. The rig consists of a nominally 1-foot-diameter pipe with a convergent cone at the end through which supersonic air flows. Two large lasers mounted on the floor send bright light upward through the jet flow. A larger platform contains cameras that image the flow from the side.

An optical measurement technique known as Digital Particle Image Velocimetry (DPIV) was used previously to characterize the first- and second-order statistical properties of both cold and hot jet flows from externally mixed nozzles in NASA Glenn Research Center's Nozzle Acoustic Test Rig. In this technique, an electronic camera records particles entrained in a flow as a laser light sheet is pulsed at two instances in time. Correlation processing of the recorded particle image pairs yields the two-component velocity field across the imaged plane of the flow. The information acquired using DPIV is

being used to improve our understanding of the decay of turbulence in jet flows-a critical element for understanding the acoustic properties of the flow.

Recently, two independent DPIV systems were installed in Glenn's Small Hot Jet Acoustic Rig, enabling multiplane correlations in time and space. The data were collected over a range of different Mach numbers and temperature ratios. DPIV system 1 was fixed to a large traverse rig, and DPIV system 2 was mounted on a small traverse system mounted on the large traverse frame. The light sheets from the two DPIV systems were aligned to lie in the same axial plane, with DPIV system 2 being independently traversed downstream along the flow direction. For each measurement condition, the DPIV systems were started at a fully overlapping orientation. A polarization separation technique was used to avoid cross-talk between the two systems. Then, the DPIV systems fields were shifted axially apart, in successively increasing steps. The downstream DPIV system 2 was triggered at a short time delay after the upstream DPIV system 1, where the time delay was proportional to the convective flow velocity in the shear layer of the jet flow and the axial separation of the two DPIV systems. The acquired data were processed to obtain the instantaneous velocity vector maps over a range of time delays and spatial separations. The velocity fields from the different DPIV systems were then cross-correlated to determine the degree of correlation remaining in the flow as the downstream convection distance was increased.

The new data provide Lagrangian measurements of the convective turbulent structures in the shear layer of an exhaust nozzle. These measurements, obtained in both cold and hot flows, will be used to validate and correct models for space-time velocity correlations-long a missing key to predicting jet noise.

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